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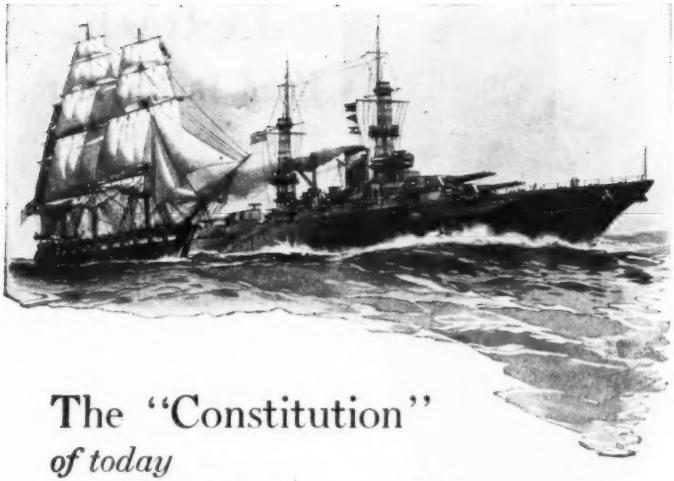

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THE COLLEGES AND THE WAR.

BY FRANK P. McKIBBEN,

South Bethlehem, Pa.

"If he deals plainly with you, it is for the love he bears you. If he were to flatter you, he would be like all the rest of the world, and you would have no one near to tell you the truth; and a worse thing cannot happen to any one, old or young."—Charles V to his son.

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COLLEGE TRAINING AND THE WAR.

It was with a feeling of wonderment that first I heard Mark Twain's "cauliflower is nothing but cabbage with a college education." The impression regarding the value of a college education conveyed by him in Pudd'nhead's calendar depends very materially on the relative positions held by cauliflower and cabbage in one's gastronomic scale. A fondness for cabbage and a distaste for cauliflower would lead one to conclude that collegiate training is undesirable. But any ambiguity concerning Mark Twain's real opinion is dissipated by reading the entire calendar, which is as follows: "Training is everything. The peach was once a bitter almond; cauliflower is nothing but cabbage with a college education."

To those who have labored diligently to place a college training on a high plane, to fill our boys with inspiration from work so well done that it can not be done better, to give them sound minds and morals in sound bodies, in brief, to those who have believed in education, the war has brought a decided sense of satisfaction. It has demonstrated the value of collegiate training. It has done more. By placing the stamp of approval on college men it has brought about an incentive for greater effort; and a just reward will come to that teacher or that student who not only sees in the remodeling and upbuilding of his college now taking place an opportunity of

real service, but who also puts forth his mightiest appeal for good. It is no time to bemoan the loss of "the good old days before the war." It is a time for patience, clear thinking, and hard work. Never was there a time when Van Dyke's words were more inspiring than now:

> "Let me but do my work from day to day,
> In field or forest, at the desk or loom,
> In roaring market-place or tranquil room;
> Let me but find it in my heart to say,
> When vagrant wishes beckon me astray,
> This is my work; my blessing, not my doom."

Our graduates and our undergraduates have nobly responded to the call to arms. So great was the rush to join the colors that many of us felt for awhile that the entire structure which we have labored so diligently to build was on the verge of a collapse and that something more than a mere palliative was needed if the machinery for training men should continue to perform its function at a time when trained men were needed as never before. Not only in numbers were college men conspicuous in government service, but many positions of responsibility and trust were fitted by them, notably President Wilson, Generals Foch, Pershing and March, Secretary Baker, Mr. Hoover, and Professor Masaryk.

That college men were considered primarily as officer material was clearly shown by the large percentage of alumni and undergraduates who received commissions. Indeed, one has but to glance at service records of any important college to conclude that collegiate training improves those qualities recognized by the army and navy as essential to leadership.

Colleges Can be Improved.

Valuable though the colleges may be, they can and will be greatly improved. And now is the time to inaugurate the changes if any are to be made. Especially at this time do students, teachers and executives long for something better. Many of them have just returned from Christmas vacations

preceded by months of such marvelous educational experiments as to make acceptable any stable, well-organized, well-operated system of training. No college faculty should let this wonderful opportunity slip from its grasp. Make the desirable changes now, as speedily as possible, and then hold to the chosen course with perseverance and determination to let no one alter the purpose of giving men a real education.

Our educational system is susceptible of improvement along the following lines: (1) Elimination of wasteful methods; (2) increasing self discipline and self instruction among students; (3) improving the status of the teaching corps, thus resurrecting, after a long death, the idea that education is or should be the main business of the college.

Elimination of Wasteful Methods.—Under this heading can be grouped the following: Consolidation of and coöperation between educational institutions; saving time; simplification and reduction in numbers of curricula. It is unfortunate that the war did not bring about the consolidation of colleges where union would result in more effectual use of men and equipment. If consolidation is not desirable, coöperation, consisting of an interchange of teachers or reciprocal use of equipment, often is possible and may result in a distinct saving of effort. And what is of equal or greater importance, coöperation resulting in interchange of teachers vitalizes the teacher, requires him to give better and more work, broadens his vision and his field of activity. The consolidation and coöperation of the Massachusetts Institute of Technology and Harvard University should be carried further. Similarly Carnegie Institute of Technology and the University of Pittsburgh, almost on opposite sides of the street could profit by consolidation or affiliation. Lehigh University, Lafayette College, Muhlenburg College, Moravian College, located as they are, could be as well operated, would have better men and equipment if they were one institution. Another of the numerous examples is the medical schools of Johns Hopkins University and the University of Maryland. And in the same city the Baltimore College of Dental Surgery and the dental

department of the University of Maryland may profitably be consolidated. These are only a few of the possibilities.

At many colleges the elimination of some courses of study would be a step in the right direction. Differentiation has gone too far.

Saving a few months or a year of time for each of several hundred thousand students is no small economy. Most college courses are of four years' duration. How much of that time is utilized. How much wasted? Would three years properly applied give as good results as four have in the past? While I believe they can, it must be confessed that most college authorities think otherwise, for nearly all institutions of learning hold to four-year curricula. Nevertheless, several colleges now contemplate operating throughout the year in such a manner as to enable capable students to complete their work in three years, while other students take four. On the other hand, Sheffield Scientific School's recent move was to increase the course from three to four years. The ordinary four-year course consists of eight terms of seventeen weeks' duration, a total of one hundred and thirty-six weeks. A three-year course with nine terms, each of fifteen weeks, has a total of one hundred and thirty-five weeks of instruction. I thoroughly believe that as much good work can be accomplished in this three-year plan as in the old four-year plan, provided the number of subjects carried by the student at a time be decreased, home study increased, loss of time during the college year eliminated, and the physical welfare of every student carefully developed. The two reasons advanced against adopting an intensive three-year plan are: loss in students' earning power during summer; and possibility that students cannot sufficiently mature, and cannot assimilate the college course, in three years. Very few data on the earnings of students during summer recesses are available, but those shown in accompanying Table I indicate that at Lehigh University the civil engineering students worked an average of 1.6 months and earned $110.00 per man during the summer of 1912. Recently 220 students from the Uni-

versity of Minnesota earned an average of $90.00 each during one summer's college recess. If these sums earned at those two institutions be a fair average, it is readily seen that the total earnings during the three summer recesses of the four-year course are not equal to the cost of the additional year's tuition and living expenses required by the four-year plan.

As to the power of students to assimilate the work in three years, I *know* little, but judging from the thoroughness in which some engineering subjects are grasped by juniors in some colleges while seniors in other institutions fail generally to do as well in the same studies, I am of the opinion that this question of effectiveness is largely one of the teachers and discipline.

In connection with the inefficient use of time during a college year, let us consider the normal school year at an eastern university as an example of an institution where good standards of scholarship are maintained and where the amount of work demanded of teachers and students is on a par with other high-grade colleges. The school year includes 260 days, of which 37 are Sundays and 223 are working days. In these 223 working days there are 51 holidays, including the half holidays of Wednesday and Saturday afternoons of each week and the vacations at Thanksgiving, Christmas and Easter and other similar periods, during which exercises are suspended. Therefore, there are only 172 days in each year upon which college exercises are held. These 172 days constitute 77 per cent. of the available working time during the school year, and only 55 per cent. of the total working time of the calendar year. It can hardly be said that an institution is efficiently managed when it utilizes only 77 per cent. of its available working period, and certainly the equipment and plant cannot be used to greatest advantage if students are present only 55 per cent. of the available working days in the calendar year. This condition is duplicated at nearly all educational institutions. Clearly the colleges are not rendering their maximum service.

Self Discipline and Self Instruction.—The best discipline

TABLE I.

EARNINGS OF CIVIL ENGINEERING STUDENTS OF LEHIGH UNIVERSITY DURING SUMMER OF 1912.

	Seniors, Months.	Juniors, Months.	Sophomores, Months.	Totals, Months.
Kinds of work:				
Municipal engineering	3	2½	9½	14¾
Machine shop	2¾	—	5½	8¼
Engineering office work	13½	6½	4½	23½
Non-engineering office work	3	5	13½	21½
Construction	5½	8¾	6½	20¾
Railroad engineering	8½	15 7/12	6	30 7/12
Surveying	11 11/12	3½	1½	16 11/12
Highway engineering	6	2	6½	14½
Hydraulic engineering	2½	—	—	2½
Farming	2	—	5½	7½
Barbering	2	—	—	2
Canvassing	—	—	1	1
Total number of months employed	60½	43 7/12	59½	163½
Number of men reporting	41	27	30	98
Number of men reporting having worked	30	20	26	76
Average number of months employed for all men reporting	1.5	1.6	1.9	1.6
Average number of months employed	2.0	2.2	2.3	2.1
For students who worked:				
Total earnings for summer, not including traveling or other similar expenses	$3,524.03	$2,282.25	$2,566.80	$3,373.08
Average earnings per summer per man, not including traveling or other similar expenses	$ 117.46	$ 114.11	$ 98.72	$ 110.17
Total earnings for summer, including traveling and other similar expenses	$3,904.13	$2,412.40	$2,843.20	$9,159.73
Average earnings for summer per man, including traveling and other similar expenses	$ 130.14	$ 120.62	$ 109.35	$ 120.52
Average earnings per month per man, not including traveling and other similar expenses	$ 58.49	$ 53.07	$ 43.13	$ 51.36
Average earnings per month per man, including traveling and other similar expenses	$ 64.80	$ 56.11	$ 47.78	$ 56.20

This table does not include the graduating class of 1912.

and instruction a student receives is that which he gives himself. We speak of mental training as if it were something

our instructors can serve to our boys on silver trays. It is merely acquiring the ability to think accurately for a reasonable period of time. And the student must acquire it by personal effort. It cannot be taught to him, although the capable teacher can lend encouragement, inspiration and guidance. As self-instruction is the best instruction, every student should spend much time in the quiet of his study, thinking out for himself the problems of class room and the greater ones of life. To learn to think is a great prize and he who acquires it gains much. The words inscribed on Portia's golden casket apply admirably, "Who chooseth me shall gain what many men desire." But this wonderfully valuable ability cannot be secured alone in the class, the laboratory or on the playground, as necessary as is the training received there. It must come from within the student himself.

If there is one phase of college life to-day which demands the earnest attention of trustees, faculties, students and alumni it is this matter of "home study," which is not now taken seriously. If this problem be solved the others will soon disappear. The solution lies in fewer subjects carried at a time, fewer "snap" courses, higher standards in the class work, and sound bodies. "I am for hard and strenuous work. I do not at all wish to make work slipshod and dilettante. I would raise the standards of simple education, and force boys to show that they are working honestly. I want energy and zeal above everything. But my honest belief is that you cannot get strenuous and zealous work unless you also have interest and belief in work." The quoted words are those of Benson, whose wonderful book, "From a College Window," should be on every teacher's desk and in his mind and heart. I wish a series of meetings could be arranged for our instructing corps where Benson's essays would be read and discussed. The reason that boys do not force themselves to acquire mental discipline in "home study" is because we teachers and you administrators do not demand it with high standards, and because we do not make our classes sufficiently interesting to inspire the boy to seek learning.

Imagine the effect produced on a class of students by a system which permits recitations of from five to ten minutes' duration, upon the completion of which the student who recites in this short time leaves the room even though the time assigned for the recitation by the college be one hour. Yet I have visited a well-known institution where this is common practice in at least two departments.

In nearly all schools too many social, athletic and other meetings are allowed to interfere with the main function. A professor recently confessed that he was not sure whether he was engaged in an educational institution or a country club. Although participation in social and athletic affairs is very desirable, indeed should be compulsory, it should be supervised and restricted. Some boys want to be ticket seller, audience, orchestra, actor and stage manager. Their desires should be restricted to a reasonable number of college activities; sufficient to develop the boy, but not to overload him. Other boys, self contained, sadly need the benefit that comes from playing on a ball team or managing some college function, but we have no system by which this type of boy is developed. We leave it to the boys. They either do nothing or overwork in non-scholastic activities. Any capable dean can devise a system of units which will afford a check on the overzealous, and an incentive to the backward boy. Compulsory but restricted participation in college social and athletic activities would be a great thing for college students. If colleges required every able-bodied student to learn at least one game fairly well—tennis, baseball, football, soccer, lacrosse, basket ball, track athletics, there would be less intercollegiate contests for the few and more games for the many. There would be more exercise and physical development by every man in college and less record-and-heart-breaking by a few. Such a system must be operated by the faculty, not by another part of the college organization, otherwise there will be divided responsibility and divided power; and this never works successfully.

Improving the Status of Teachers.—The man who has the

ability and desire to teach should be a teacher. It is a noble calling. The reward is great; not so much perhaps in material things as in some other fields of activity, but in contact with young enthusiastic life which responds generously either to help or constructive criticism. We must appreciate the importance of doing our work thoroughly. A few things well done is the net result of most lives, even though active. If Verdi had written only the Miserere in "Il Trovatore" he would have added his share to the world's progress. Unselfish service is sooner or later recognized. Possibly the undergraduate may not realize what is being done for him. But let us not forget that the undergraduate of to-day becomes the alumnus of to-morrow, and as such he will look back on good teaching, kindness in his hours of trial, discipline justly administered when justly due, as helps in moulding his character and then his friendship and respect become the part of our reward. "I respect my calling and as long as I do others will respect it and me," should be the attitude of every teacher. College graduates frequently remark that they would not "waste their time teaching because there is no money in it." Such a man could not teach if he tried. His desire for wealth would render it impossible for him to give unselfish service.

Ask college administrators, students, teachers and alumni how to improve the status of teachers and the reply will almost invariably be "pay them larger salaries to attract more capable men." Greater remuneration would help (indeed is sadly needed), especially by raising the standard of living and by making it possible for the teacher to save a portion of his earnings. But the way to improve the status of the teaching corps is to give it some responsibility and power. In no other way can young men be developed into broadminded teachers worthy of the task of guiding your son and mine. *It is surprising that many college administrators do not realize that by keeping their teaching staff in the background they are taking the most effective method of dwarfing its initiative, destroying its ambition and rendering it impotent.*

TABLE II.

NORMAL SALARIES PAID HEADS OF DEPARTMENTS AT SOME MIDDLE STATES COLLEGES.

Institution.	Salary per Year at Present.	Institution.	Salary per Year at Present.	Institution.	Salary per Year at Present.
A	$1,300	G	$2,200	M	$3,000–$4,000
B	$1,400	H	$2,400 and house	N	$5,000
C	$1,900	I	$3,000+	O	$5,000
D	$1,900	J	$3,000	P	$5,000
E	$1,925	K	$3,500		
F	$2,000	L	$3,600		

To develop a man, give him power and responsibility. If this were done with teachers the result would be wonderful. The war has brought this out most forcibly. Because of increased duties or of a shortage of men many instructors and professors have been called upon to enlarge their activities either within the college or in industrial or government service. In numerous cases the results have been most gratifying. More than one college president has remarked to me during the past year that he did not realize how much ability professor "so and so" had until he called the professor in to perform some work, or how capable a certain instructor was until the government had given him an important duty to do.

It is not so much that higher salaries are needed, though they would help, but that more attention should be given to coöperation between administrative officers and the teaching corps.

It is the very common opinion among the best college professors that college administrators could accomplish much greater good by working through the medium of their faculties and instruction corps than by working single-handed. The study of organization and management methods receives altogether too little attention. I have been connected with two important institutions for twenty-four years and I have never seen an organization chart in either of them. And yet a college is a very complicated organism as was clearly shown recently when the War Department became a factor in college

administration through the Students Army Training Corps system.

Table II shows the maximum salaries paid to professors by colleges in the Middle States. For obvious reasons the names of the colleges are withheld, the institutions being designated by letters. Notice the number that pay heads of departments below $2,000 per year. Such schools have no reason for existence. The professor of middle age who accepts a salary of that kind cannot perform properly his function because he is constantly confronted with the vision of poverty in old age. And yet we ask him to teach our sons chemistry, mathematics, character, French or fair dealing.

The accompanying chart shows the total incomes, salaries received from teaching, expenditures and savings of two professors in eastern universities. One has been teaching three or four years, the other about twenty years. The older man in question has always been more or less active in engineering practice outside of his institution and the effect on his total incomes due to this is clearly indicated. Relatively few teachers are so situated and constituted as to be able to materially increase their salaries by added effort outside of their colleges.

Many colleges are making the mistake of not getting their teaching corps together socially. Much is done in this line for students, and properly so; but almost nothing is done to bring about coöperation among teachers and departments. In some colleges the teaching corps is frequently assembled for the sole purpose of discussing educational problems. Much profit results from a carefully prepared discussion on such topics as recently treated in the Report of the Carnegie Foundation setting forth rules for admission of institutions and for the granting of retiring allowances to teachers. This is a new contributory system of providing old age annuities for college teachers and a few meetings spent in discussing the features of the plan and the desirability of the teachers availing themselves of its advantages would be profitable. Again, a short series of discussions of Dr. C. R. Mann's report

on engineering education would quicken the interest of every teacher in the school if a program of the discussion be arranged in advance in order that each participant would be prepared to contribute something of merit. Moreover, it would be very helpful to send singly a limited number of instructors each year to educational institutions somewhat removed from the one wherein they teach normally to inspect methods of teaching, organization and equipment. Let each man remain a sufficient time to become well acquainted with the institution and to write a report on what he sees and learns, which upon his return should be read before his colleagues. To be of most value considerable emphasis must be placed on the quality of the report and upon its presentation. Similarly instructors would derive much benefit from being sent to conventions of national societies, alumni meetings, and for teachers of engineering, to great engineering works, provided the reading of a good report be insisted on. This cooperation would soon develop greatly the strong young men in the teaching corps, and improve the weak ones.

Depletion of Colleges Due to the War.

The colleges have been greatly depleted, especially in the three upper classes. They have likewise been badly disorganized and in the reconstruction about to take place some important improvements can be instituted. Many visits to colleges during the year 1918 has enabled me to see the changes wrought by the war. At one institution a single student constituted the class in physical laboratory and the professor of physics was laboring with him as diligently as if the laboratory was filled. At another, a professor of civil engineering was teaching bridge design to three students, and the head of the mechanical engineering department spoke of his senior class as "my senior," for he had but one man in the senior class. A college which, last year, had eighteen men in the senior class of one of its engineering departments has five this year. Scores of cases like these can be cited to show

the very great depletion in the upper years. In the autumn of 1918 the freshman classes were filled by the Students Army Training Corps.

The situation during the college year 1917–18 was about as follows: The army and navy were taking not only the entire output of the engineering schools, but were sucking the life-blood of these institutions by taking the undergraduates before they reached the ends of their courses. Both raw material and finished product were absorbed. But what was of equally grave importance was that the machinery of production was taken when the teachers enlisted in the army or navy, or left college to enter the industries. Raw material, finished product, machinery of production all were going. This draining process had been going on for two years and the demands of the War and Navy Departments were pressed regardless of the needs of the industries, and regardless of the life of the college. The predicament in which the college found itself was of no consequence as far as the college was concerned. It gave willingly and generously all it had to give. When, however, the technical colleges failed to supply technically trained men to the army, navy and essential industries it became necessary to give immediate relief to the college. This was attempted by the War Department by making it possible for students who met certain requirements to enlist in the Engineers' Reserve Corps. But as only those were eligible for this appointment whose academic standard was such as to place them in the "upper third," this provision was a failure as far as maintaining a normal supply of students under technical training was concerned. In the face of an unprecedented demand for technically trained men an acute shortage existed in the supply, and the reservoir, *i. e.*, the technical schools, from which they would normally be drawn, were nearly drained of upper classmen who had had sufficient training to make them serviceable.

Another system devised to give military training to students and to hold them in college to be ready when needed was the Reserve Officer Training Corps. This worked admir-

ably during its brief trial of 1917 and 1918 and is an excellent plan for peace times. While it gave military training to students after they had entered the colleges, it was not instrumental in attracting men there, nor did it afford financial aid to students or colleges.

The Reserve Officers' Training Corps is the outgrowth of the students' summer military camps first proposed by General Leonard Wood in letters sent to college presidents in the spring of 1913 urging the establishment of the first camp at Gettysburg. This camp was succeeded by one at Burlington, Vt., in 1914, and those at Plattsburg every summer since. The Plattsburg idea has become an essential part of our military training for college men. Dr. Drinker and Dr. Hibben have from the beginning in 1913 been the leading spirits among college presidents in advocating the value of a six weeks' training at the summer camps and to them the country owes much for having perfected a system which when war came admitted of great and rapid expansion in producing officer material.

The Reserve Officers' Training Corps as outlined by the War Department in General Orders Number 49 provides a system for giving college students brief training in military science and tactics which if satisfactorily completed leads to appointment as reserve officers to be called upon in time of national emergency. Briefly outlined, it is as follows: The War Department provides officers, uniforms, arms and other equipment to those colleges which agree to maintain a two years' elective or compulsory course of military training and where at least 100 able-bodied students voluntarily join an R. O. T. C. unit, under an agreement which requires three hours per week to be devoted to military science and tactics during the freshman and sophomore years. Of the three hours, one is for a lecture, the other two are devoted to drill. Although elective, when once entered upon the military course becomes a prerequisite for graduation. Summer camps are not required of freshmen and sophomores. At the end of the sophomore year the student may discontinue, or he may, if

recommended by the professor of military science and the president of the college, continue the work, taking five hours per week throughout the junior and senior years and also the summer training in camps. In case a student agrees to take the work of the junior and senior years, he may be furnished by the government with commutation of subsistence, which in the past has amounted to only thirty cents per day. While going to and from, and while residing at summer camps maintained for the practical instruction for a period of not exceeding six weeks in any year, members of the R. O. T. C. have subsistence furnished by the United States, and they also receive their traveling expenses if appropriation permits. The President of the United States is authorized to appoint as reserve officers in the army, not exceeding 50,000, graduates who satisfactorily complete the four years' course, to serve the United States as reserve officers during at least ten years after appointment. In peace times the President may appoint and commission any reserve officer as a temporary second lieutenant for purposes of instruction for not exceeding six months. In times of war he may order them to active duty.

While enlistment in the Engineers' Reserve Corps, previously mentioned, was beneficial in holding a few capable men in college till the end of the college year in the summer of 1918, this system would have been found totally inadequate had it alone been relied upon and had the war continued. Accordingly, in the summer of 1918 the War Department announced the Students' Army Training Corps, which was the only practical system for securing office material and providing training for the young men who were thus brought together. That some drastic action had to be taken if the supply of technically trained men was to be maintained was clear to anybody who had visited the colleges in the spring of 1918. The accompanying diagram shows the decrease in number of men graduating from Lehigh University in the last five years, and the same conditions existed at all colleges.

In June, 1918, Table III (herewith presented) was prepared to ascertain the number of men graduating from the civil, mechanical and electrical engineering courses of the principal colleges. These three courses have in the past furnished nearly the entire output of engineers. The total number of men graduating last June is shown by the table to be 1844, and as most of these went into the army and navy a totally insufficient remainder was available for the essential industries. Moreover, this table clearly shows that the colleges were operating very inefficiently because many of them were graduating less than half a dozen men in each of the three important engineering courses. Indeed the average of all schools tabulated was only eleven men per course per school. This great falling off from previous years took place in the face of an unprecedented demand for technically trained men.

In his work among the shipyards and colleges the writer had an excellent opportunity of seeing on one hand the demand for men and on the other the dwindling supply. A total of forty colleges were visited on the Atlantic and Pacific seaboards, 114 lectures given, 23,400 miles traveled and about 900 technically trained men placed in shipyards. Depletion of the upper classes had taken most of the available men by September, 1918, and as the demand from the shipyards were still very great, several colleges started intensive training courses in naval architecture and marine engineering. Of these, the Massachusetts Institute of Technology's course of ten weeks' duration for technical college graduates working all day, every day, was very successfully carried out.

Another interesting method of increasing the output of technically trained men was that adopted by Cornell, Massachusetts Institute of Technology, and Throop College of Technology. These institutions continued their regular work during the summer and autumn of 1918 for their junior classes, thus graduating, between September and December, 1918, men who otherwise would have finished in June, 1919. Just before the men graduated at Massachusetts Institute in

TABLE III.

NUMBER OF MEN GRADUATING FROM LEADING ENGINEERING COURSES IN SPRING OF 1918.

Civil Engineering.		Mechanical Engineering.		Electrical Engineering.	
Institution.	No. of Graduates.	Institution.	No. of Graduates.	Institution.	No. of Graduates.
Cornell Univ.....	42	Stevens Inst.....	66	Mass. Inst. Tech....	43
Univ. of Michigan .	42	Mass. Inst. Tech. .	53	Penna. State Col....	34
Mass. Inst. Tech. ..	40	Univ. of Mich....	36	Univ. of Michigan .	34
Cooper Union	39†	Georgia Tech.	30	Cornell University..	30‡
Rensselaer P. Inst..	27	Cornell Univ.....	30‡	Univ. of Illinois ...	29
Iowa State College .	26	Univ. of Illinois ..	26	Univ. of Wisconsin.	26
New York Univ....	21	Univ. of Wis.....	26	Iowa State College .	23
Penna. State Col...	20	Sheffield School ...	23	Renesselaer P. Inst.	22
Univ. of Illinois ...	20	Case School	20	Worcester P. Inst...	20
Lehigh University ..	19	Penna. State Col. .	19	Cooper Union	19†
Brooklyn P. Inst...	18	Clemson College ..	17‡	Univ. of Colorado..	19
Univ. of Penna....	18	Worcester P. Inst..	15	Clemson College....	17‡
Univ. of Wisconsin .	17	Brooklyn P. Inst..	14	Union College.....	17
Univ. of California .	17	Lehigh University.	14	Georgia Tech.	17
Case School.....	15	Syracuse Univ.....	13	Univ. of Missouri ..	13
Cooper Union.....	15*	Univ of Penna....	13	Ohio State Univ....	12
Ohio State Univ....	14	Oregon State Col..	12	Syracuse Univ.....	12
Tufts College	13	Univ. of Minn....	12	Univ. of Kansas ...	12
Worcester P. Inst...	12	Iowa State Col. ...	11	Virginia P. Inst. ...	12
Clemson College....	11	Rensselaer P. Inst.	11	Carnegie Tech.....	11
Lafayette College...	11	Ohio State Univ...	10	Miss. A. & M. Col. .	11
Syracuse Univ.....	11	Carnegie Tech.....	9	Univ. of Maine....	11
Univ. of Missouri ..	11	Univ. of Colorado.	9	Univ. of Minnesota.	11
Leland Stanford Jr..	10	Brown University .	8	Case School.....	10
Univ. of Colorado..	9	Kansas State Univ.	7	Kansas State Univ.	10
Univ. of Wash.....	9	Leland Stanford Jr.	7‡	Sheffield School	10
Washington Univ...	9	Johns Hopkins		Oregon State College	8
Carnegie Tech.....	8	Univ.....	6	Univ. of Penna.....	8
Sheffield School	8	Lafayette College .	6	Johns Hopkins Univ.	7
Union College.....	8	New York Univ. ..	6	Leland Stanford Jr..	7‡
Univ. of Minn.....	8	Univ. of California	6‡	Texas A. & M. Col..	7
Georgia Tech.....	7	Univ. of Maine ...	6	Throop College.....	7
Throop College.....	7	Cooper Union.....	5†	Lafayette College...	6
Univ. of Vermont..	7	Tufts College.....	5	Lehigh University..	6
Kansas State College	6	Miss. A. & M. Col..	4	Univ. of Texas	6
Texas A. & M. Col..	6	Tulane University.	4‡	Wash. State College	6
Univ. of Utah	6	Virginia P. Inst....	4	Brooklyn P. Inst. ..	5
West Virginia Univ.	6	W. Va. University.	4	Univ. of California.	5
Johns Hopkins Univ.	5	Univ. of Kansas ..	3	Univ. of Oklahoma.	5
Tulane University..	5	Univ. of Missouri.	3	Cooper Union	4*
Univ. of Maine....	5	Univ. of Oklahoma	3	Tulane University..	4‡
Univ. of Texas.....	5	Washington Univ..	3	Univ. of Vermont..	4
Univ. of Kansas ...	4	Texas A. & M. Col.	2	Univ. of Washington	4
Univ. of So. Carolina	4	Univ. of Arkansas.	2	West Virginia Univ.	4
Columbia Univ.....	3	Univ. of Vermont.	2	Brown University ..	3

Civil Engineering.		Mechanical Engineering.		Electrical Engineering.	
Institution.	No. of Graduates.	Institution.	No. of Graduates.	Institution.	No. of Graduates.
Miss. A. & M. Col...	3	Wash. State Col...	1	Univ. of Arkansas..	3
Univ. of Arkansas..	3	Throop College ...	1	Univ. of So. Calif...	3
Univ. of So. Calif...	3	Univ. of Utah	1	Washington Univ...	3
Vanderbilt Univ. ...	3	Univ. of Wash.	1	Univ. of Utah	2
Brown University ..	2	Vanderbilt Univ...	1	Tufts College.....	1
Oregon State Col. ..	2	Columbia Univ....	0	Univ. of Florida ...	1
Univ. of N. Carolina	2	Cooper Union.....	0*	Univ. of N. Carolina	1
Univ. of Oklahoma.	2	Univ. of Alabama.	0	Northwestern Univ.	1
Virginia P. Inst.....	2	Univ. of Florida ..	0	Columbia Univ.....	0
Northwestern Univ.	1	Univ. of N. Carolina	0	Univ. of Alabama..	0
Wash. & Lee Univ..	1	Union College	—	Vanderbilt Univ....	0
Univ. of Florida ...	0	Univ. of S. Calif...	—	New York Univ....	—
Univ. of Alabama..	0	Univ. of Texas ...	—	Stevens Institute...	—
Wash. State Col....	0	Wash. & Lee Univ.	—	Univ. of S. Carolina	0
Stevens Inst.	—	Univ. of S. Carolina	—	Wash. & Lee Univ..	—
Total	648		590		606
Average.....	11		11		11

* Day school students.

† Night school students.

‡ Combined mechanical and electrical engineering courses.

September a representative of the Emergency Fleet Corporation gave a lecture on shipbuilding and an engineer from the Newport News Shipbuilding and Dry Dock Company engaged twenty-eight members of the class, who reported to the shipyard immediately upon graduation. Each of the above colleges have the unique distinction of having graduated two classes in the same year. An interesting detail of this intensive system was seen at Throop College, where students and faculty gathered upon the campus every morning at ten o'clock for fifteen minutes' physical training, this being possible through the winter under southern California's clear sun.

The Course of Study.

War has resulted in a searching analysis of college courses of study. Except in vocational training the very important question of "how to teach" has not received as much atten-

tion as "what to teach." While both are of great importance, it is to the college curricula that attention is now directed, because their revision is under consideration by most faculties.

Choice of Vocation.—Most students have not, upon entering arts courses, chosen their vocation and perhaps it is well that it is so for the boy then has an opportunity to learn for the sake of learning. And yet I believe that the classical college would do better if it gave in the freshman or sophomore year a course of lectures planned to instruct the boys about the professions as well as the different fields of industrial and commercial activity. With the professional schools of medicine, law and engineering it is somewhat different. When boys go to an engineering school they do so with the purpose of becoming engineers, and while they generally have a fairly clear idea as to the particular engineering course they desire, a few students change from one course to another during their freshman year. Such changes are readily made without loss of time because the various engineering curricula are practically identical in the first year. Most boys, however, who enter engineering courses remain therein and continue engineering work after graduation. They have the builder's instinct and nothing can and nothing should deviate them from their purpose.

Professional and Cultural Subjects.—Students of engineering have in general too many subjects at one time. They have too many technical courses and unfortunately have very little interest in those of non-technical nature. A so-called cultural subject must be taught in an excellent way to hold a class of young engineers. In saying that there are too many technical subjects I do not wish to belittle them, for I consider them of prime importance. They must continue to demand the student's respect, his interest, and his best work. But he must know something besides his applied science. Assuming a corps of instructors of equally good ability it seems that an undergraduate engineering course should be one third cultural and general science studies, one third eco-

nomics and one third applied science. And where in the curriculum is the best place for these various subjects? Let us put ourselves in the boy's place. He has looked forward for several years to his entrance into his engineering college course. At last he reaches the campus, and his heart is filled with admiration and joy. His hopes are about to be realized. He finds the campus and buildings a most beautiful and inspiring sight and his enthusiasm runs high. It is with these feelings that he approches "old hall" for his first recitation. He expects something new, something better, than he had at high school. But he finds he has almost exactly the same subjects to study—mathematics, English, French or German, chemistry or physics. His enthusiasm drops x per cent. at the first recitation and another x per cent. at those immediately following as he rushes from building to building in the hope of finding something to satisfy his longing to become an engineer. If he stands the test he passes over this bridge of sighs and into work of subsequent college years. But he frequently is unable to overcome the transition period from high school to college and fails; leaving college at either the end of the first or second terms of the freshman year. It is stated that only 40 per cent. of engineering students graduate in the allotted time. I know of no careful analysis having been made as to the causes of failure at institutions with which I have been a part, but I believe the loss of enthusiasm in the freshman year is an important contributory influence. It is not to belittle the studies—mathematics, French, English, etc.—mentioned above that these remarks are made, for those studies are of great importance, in fact essential. But is it proper to give all the technical work above the freshman year? I think not. A boy coming to college with the feeling described above should have some entirely new work; and it should be of the highest grade, even though purely inspirational. Our courses supply either inspiration, information or mental training. Obviously, care must be taken to give no work in the freshman year which will be repeated in later years.

The proper place in the curriculum for cultural work is a difficult thing to decide. It is, however, clear that some of these subjects can properly come in the upper rather than the lower years and if a boy is given some technical work in his freshman year and cultural subjects later may he not approach the latter with greater interest and better results.

Engineering is largely concerned with making a dollar do the greatest amount of effective work. Economics is, therefore, an essential tool for the engineer and he should have in college the fundamentals, including work in accounting, business law, banking and industrial management. The writer confesses that he was past thirty years of age before he knew that he could discount at a bank a note he had received in payment for professional services rendered. He was ignorant of the fact that he could, by discounting the note, receive his money immediately and not wait for it till the date of maturity. No engineering student should be ignorant of such a simple, fundamental banking operation.

College faculties are now trying to answer these questions: How many exercises per week should a student have? How many hours of class room work and hours of home work? How many subjects should the student carry at once? As college teachers and students are constituted eighteen exercises per week can be placed in the schedule with an allowance of two hours, for preparation for each, or fifty-four hours of combined class work and outside preparation per week. It would be very much better if most professors maintained a higher standard. In this case twelve exercises per week would be ample with three hours of serious work required outside for each exercise. This would permit about four subjects at a time and to include all the subjects now thought desirable in engineering courses more than four years would be required, because even by operating three terms per year only 48 eight courses of study could be included. This is less than most schools now give as shown by Table IV. But too many courses are now required. Imagine the mental gymnastics demanded of a boy who in one morning is ex-

TABLE IV.

NUMBER OF SUBJECTS IN CIVIL ENGINEERING CURRICULA AT SOME TYPICAL INSTITUTIONS.

	Freshman.		Sophomore.		Junior.		Senior.	
	1st Term.	2d Term.	1st Term.	2d Term.	1st Term.	2d Term.	1st Term.	2d Term.
Massachusetts Inst. of Tech.	6	7	7	9	9	9	8	8
Princeton University	6	6	6	6	6	6	6	6
Carnegie Institute	5	7	5	6	6	7	7	9
Cornell University	5	4	6	5	5	6	6	6
Pennsylvania State College	6	6	6	6	6	7	8	9
Lehigh University	6	5	6	6	6	6	6	6

pected to do serious work in French, physics, mathematics, chemistry—a common requirement.

It would be well worth while to try a three-year course with three terms per year with five subjects per term. Tufts College announces a program of three subjects in each of three terms yearly.

SUDENTS' ARMY TRAINING CORPS.

The primary purpose of the Students' Army Training Corps (S. A. T. C.) was to utilize the executive and teaching personnel and the physical equipment of about 600 educational institutions to assist in training our army and navy, especially for training officer-candidates and technical experts of all kinds needed in the service. The corps was divided into two sections, the "collegiate" and the "vocational." Before the S. A. T. C. was authorized by Congress in the summer of 1918 the War Department had been conducting training centers for instructing soldiers as trade specialists in the army. This vocational training reached enormous proportions and varied in character from excellent to mediocre. Automobile mechanics, carpenters, railroad track men, road builders, instrument repair men, were among the many types of workers taught in these training centers, which were in most cases located at colleges. It was a relatively simple matter to expand this vocational training system into the larger

one which also encompassed the regular college students in about 600 institutions at which S. A. T. C. units were established.

Advantages of S. A. T. C.—The S. A. T. C. had some very good qualities, notwithstanding the fact that we, the professors, were very restive under the system. In the first place, it created a large reservoir of young men in the collegiate section which, had the war progressed for a year or more, would have been a source of great help in producing officer-material. Here we had the picked youth of the country, under training, ready to go when called, even straining at their leashes to go before; and ready to make the last great sacrifice if need be. This material was being trained physically and mentally. Practically every college president with whom I have talked stated that the students were greatly improved physically. At Pennsylvania College, Gettysburg, Pa., students gained an average of 11½ pounds in weight during their S. A. T. C. training.

The system enabled many boys, who otherwise could not have done so, to start on a college course. Their clothing and subsistence were furnished by the government and in addition they were paid by the War or Navy Departments. The mental and physical training outlined by the War Department would have meant much to thousands of our country's young men.

Many a college owes its present existence to the S. A. T. C. because the demand for men and the desire of the young men themselves to enlist in the service would have left many colleges without students at their opening dates in the autumn of 1918. Financially it saved many a struggling institution. As a result of the inducements held out by the S. A. T. C. thousands of students went to college because they saw a short cut to an officers' training camp and as the colleges received $1.00 per day per student for food and shelter and from fifty cents to $1.00 per day additional for instruction, these institutions were properly reimbursed for the use of their men and equipment.

The infusion of new blood into the colleges made many new problems, the solution of which quickened the teaching corps and administrative officers, made them help in winning the war and instituted a searching analysis as to their aims and methods. Many teachers whose classes were small and who felt they were not utilizing their ability to the best advantage by remaining in college either enlisted in the Army or Navy or entered other governmental service of the industries.

Disadvantages of S. A. T. C.—It is unfortunate that the S. A. T. C. system did not have a fair trial. In general, the only place wherein the system failed was in educational work and in some schools even this was fairly well maintained. In the first place Congress passed the enabling legislation so late in the summer of 1918 that the War Department did not have time to work out the problems before colleges opened. Then came the influenza epidemic and colleges were turned into hospitals. Some institutions did not attempt to begin educational work before November 15, *i. e.*, two months or more after they should have started. The students were kept at these colleges, drilling but attending no classes. Of course, the fundamental errors in inaugurating the S. A. T. C. were soon apparent. The divided power and responsibility between military officers and college authorities could never be made to work. Young officers, many of whom had never had any real authority or responsibility before, thought the government had "taken over" the colleges and thereupon assumed full control, thus going far beyond their orders and far beyond the desires of the committee in charge in Washington. The scarcity of officers of sufficient education and breadth of view to coöperate with colleges constituted a serious handicap. One extreme case was that of a lieutenant actively in charge at one of the best schools in the country, who was, in the spring of 1918, a student in a second-rate college preparing to enter said school in the autumn of 1918. While serving in command at the school he had charge of several hundred men every one of whom was a college graduate. Another was that of a young lieutenant who remarked to a

visiting government official about the college president, "He don't cut no ice here."

Then, again, these young officers lost sight of the fact that officers, not privates, were being trained, and while military discipline was an essential part of the student's training he also must have academic training. Imagine if you please a coast artillery officer without training in mathematics. Yet much time was wasted by unnecessary military duties which interfered with, or totally excluded, academic work.

The effect on student attendance on classes is shown by the accompanying diagram giving percentages of absences from the most important engineering subject of an eastern technical school. Before the war began in 1914 the absences were fairly small, not exceeding 4 per cent. The unrest caused by the war increased the absences from 1914, till, in the autumn of 1918, the combined influence of influenza and S. A. T. C. nearly wrecked the course with absences of 7 to 32 per cent. This interference was a very serious source of friction between most faculties and military officers and unfortunately the officers seldom appreciated the extent of the evil or even that an evil existed.

Most of us college men were apt to view the S. A. T. C. only through our short focus lenses. We saw the interference with our classes, we felt the loss of authority we had so long held and we were so far away from the real scene of activity, namely, Chateau Thierry that we could not see the necessity of a reservoir for officer material. The enemy was almost at the gates of Paris, and had he then broken through the battle front the result probably would have been disastrous. At this critical moment the need for officers was very great; the only way to get them was to train them; and the colleges were called upon to coöperate with the War and Navy Departments to do it. The colleges responded as they are ever ready to respond. And if the occasion ever again presents itself the colleges will say, "We are ready to serve."

THE JOHNS HOPKINS UNIVERSITY.

BY J. B. WHITEHEAD,
Professor of Electrical Engineering.

HISTORICAL.

The Johns Hopkins University was founded by Johns Hopkins, a merchant of Baltimore, who bequeathed the greater part of his estate for the establishment of a university and a hospital. The founder died in 1873. The first President of the University, Daniel C. Gilman, was inaugurated in 1876 and instruction began on October 3 of that year.

The work of the University began in two houses at the corner of Howard and Little Ross Streets, in the heart of Baltimore. As the need arose, other buildings were constructed, including the chemical laboratory, biological laboratory, physical laboratory, gymnasium, a home for the Young Men's Christian Association, and finally McCoy Hall, a large central building containing offices of administration, assembly room, the general library, and numerous smaller rooms for seminaries, departmental libraries, class rooms, etc. This entire group of buildings, excepting the chemical laboratory, was vacated in the summer of 1916.

The Johns Hopkins Hospital was dedicated May 7, 1889, and this paved the way for the opening of the Medical School of the University four years later in 1893. The Hospital occupies a commanding site in the eastern part of Baltimore at a considerable distance from the first home of the University, and also from the new home of the University, to be described below. The buildings of the Medical School are adjacent to those of the Johns Hopkins Hospital, with which it is closely associated, in accordance with the expressed wish of the founder. The group of buildings includes a central structure chiefly devoted to administration, large private

wards, a considerable number of separate buildings containing the public wards, a large dispensary building, a surgical building and amphitheater, a pathological institute, a nurses' home and the four buildings comprising the laboratories, library, seminaries and class rooms of the Medical School. The Harriet Lane Home for Invalid Children, the Phipps Psychiatric Clinic, the Phipps Dispensary for the Treatment of Tuberculosis, and the Brady Urological Clinic are important adjuncts to the Hospital and are situated within its grounds.

Only students who have taken a baccalaureate degree are admitted to the Medical School. Professional training in this school, therefore, is on a strictly graduate basis. It constitutes one of the most important fields of activity of the University, but no further description can be attempted within the purposes of this article.

In 1902 it was announced that a suburban site, embracing 176 acres of land within the city limits and about two miles directly north of the Washington Monument had been given to the University by a small group of its friends. A gradual development of the new site was begun at once and continued, as necessary funds were received, until 1916, at which time a practically complete move of all the work of the University, except that of the Medical School, was made to new buildings at "Homewood."

The principal building of the present Homewood group is Gilman Hall, which contains the general library and all of the non-laboratory departments, as well as the offices of administration. Other buildings are those of the Department of Engineering, described below, the Laboratories for Botany and Plant Physiology, the Students' Activities Building and the original Carroll Mansion, built by Charles Carroll, the signer, in 1809, to be a residence for his son, and which is now known as the Johns Hopkins Club. Plans for the physical and chemical laboratories are completed and construction will soon be begun on at least one of these. Plans are also under way for the erection of the first of a dormitory group within

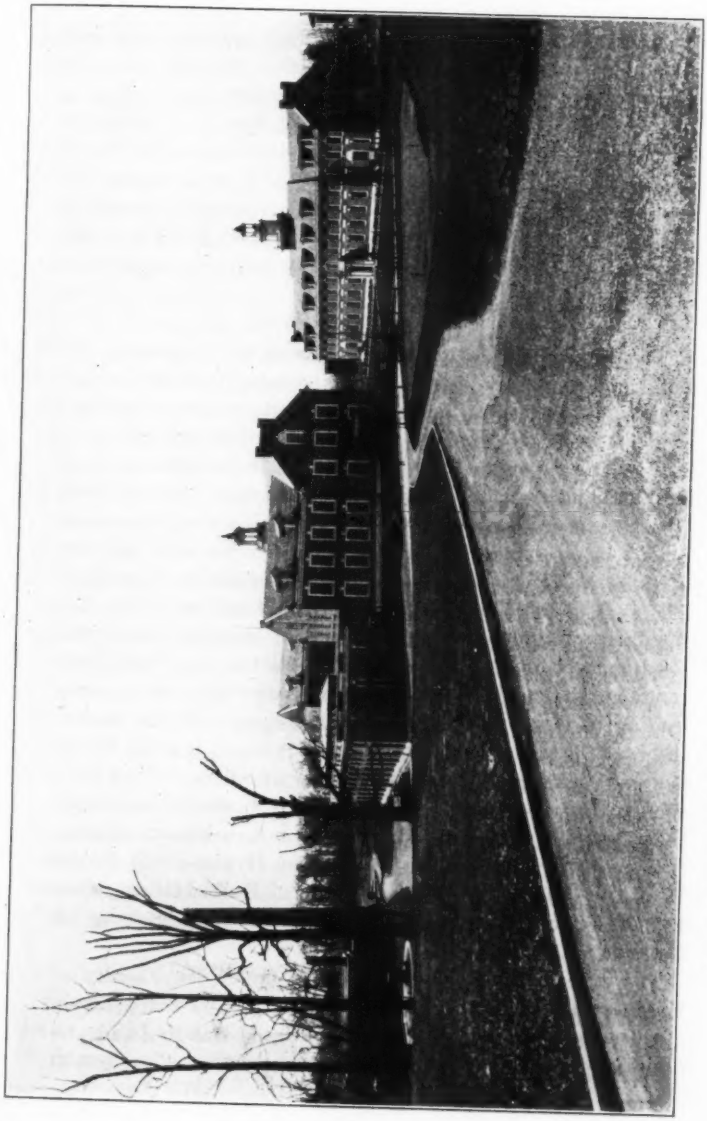

FIG. 1. Power Station, Mechanical and Electrical Laboratory, Civil Engineering Laboratory.

the near future. At present temporary quarters are provided in Gilman Hall and in the engineering buildings for the laboratories of physics, chemistry, geology and biology.

In 1916 the Rockefeller Foundation of New York offered to coöperate with the University in the establishment of a School of Hygiene and Public Health, which offer was accepted by the University, and courses of instruction were opened in 1918. The temporary home of the School of Hygiene is the former physical laboratory of the University, in the heart of the city.

Courses of Instruction.

The University has had in view, from the beginning, two main objects—the advancement of learning through investigations conducted by its teachers and its properly qualified students, and the communication of learning through carefully planned courses of instruction. The facilities which it provides and its methods of administration are intended both for the encouragement of research, in the case of those competent to undertake it, and for the discipline and guidance of those whose chief concern is the acquisition of knowledge. The work of the University is carried forward under the four faculties: of Philosophy, of Medicine, of Hygiene and Public Health, and of Engineering. The Faculty of Philosophy conducts the principal graduate activity of the University leading to the degree Doctor of Philosophy. It also directs the work of the College of Arts and Sciences leading to the degrees Bachelor of Arts and Bachelor of Science. The character of instruction under the Faculty of Medicine has already been described. Both graduate and undergraduate instruction are conducted by the Faculty of Hygiene and Public Health leading to the degrees Doctor of Public Health, Doctor of Science in Hygiene, and Bachelor of Science in Hygiene.

The students who may be enrolled under the Faculty of Engineering are: (1) those who have obtained degrees in engineering from schools or colleges in good standing and who desire to follow advanced courses or pursue investigations in

engineering subjects, and (2) undergraduate students who are looking forward to the degree Bachelor of Engineering. This degree is conferred on completion of four years' courses in either Civil, Electrical or Mechanical Engineering. Noteworthy features in the character of the undergraduate instruction are two years in common for all students, sound training in mathematics and in underlying sciences, one full course in a general educational subject in each year, an interrelation among the professional studies of the third year, and a working relation with the industries of Baltimore for the placing of students in industrial work during the second and third summers. The Department of Engineering also supervises a course in Chemistry, in which special emphasis is laid on the industrial applications of that science. This course leads to the degree Bachelor of Science in Chemistry.

Graduate courses are scheduled in each of the three branches of Engineering mentioned above. So far the number of graduate students has been small. It is the policy of the University, however, to encourage original investigation, not only through graduate students, but through the work of its faculty. Noteworthy contributions as a result of these activities have been made in the following directions: a method for purification of lubricating oils; the rapid cooling of water of condensation; the recovery of the by-products of the manufacture of illuminating gas; the design of power station chimneys; the electric properties of air; the measurement of high alternating voltage; the measurement of iron losses at high frequencies; the errors of polyphase wattmeter connections; the predetermination of the regulation of continuous current machines; the magnetic analysis of steel for rifles; an electromagnetic method of submarine detection; tuning fork control of the speed of large continuous current motors.

The Engineering Laboratories.

The Department of Engineering was established under the provisions of an Act of the General Assembly of the State of Maryland in its session of 1912. The Act provided a liberal

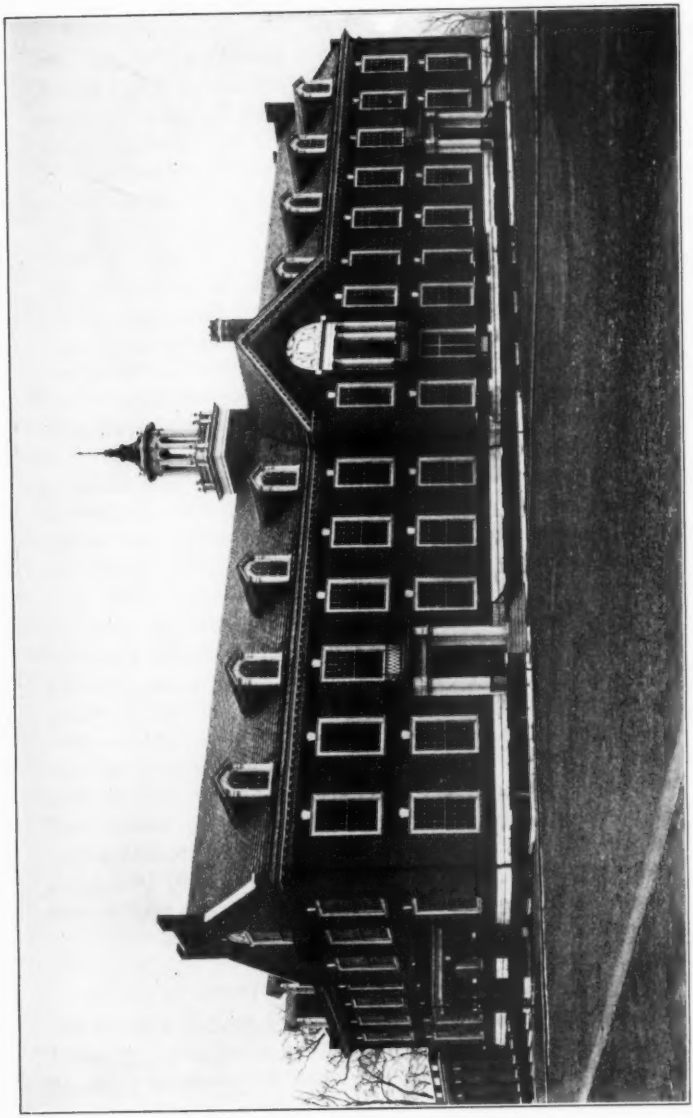

FIG. 2. Mechanical and Electrical Engineering Laboratory.

appropriation for the erection of the buildings and the purchase of equipment and a continuing annual appropriation available to the University each year. Instruction was begun in the fall of 1913 in the original buildings of the University located in the heart of Baltimore. In October, 1914, the work of the Department of Engineering was removed to the first of its laboratories at the new home of the University located at Homewood, in the northern part of the city. Since that time the first group of engineering laboratories has been completed.

In Fig. 1 is shown a general view of the engineering laboratories located on the south quadrangle of the Homewood campus. In the center is the Laboratory of Mechanical and Electrical Engineering; to the right that of Civil Engineering; and to the left the Power Station, in which is installed a considerable portion of the laboratory equipment in Mechanical and Electrical Engineering. In these buildings instruction is conducted in the subjects Civil, Electrical and Mechanical Engineering, and in Industrial Chemistry.

FIG. 2. Mechanical and Electrical Engineering Laboratory.

MECHANICAL AND ELECTRICAL BUILDING.

This building was designed to meet the requirements of both graduate and undergraduate instruction, with liberal provision for experimental investigation. It provides ample lecture and drafting rooms, research rooms and laboratories, in addition to offices, auditorium, and such other service rooms as are required for the convenience of students and faculty.

The building faces west on the south quadrangle of the Homewood development and has a frontage of 204 ft. At either end a wing extends eastward and the two wings are joined at the back by Machinery Hall. The depth of the building is approximately 160 ft. and the ground plan, including areas, covers an area approximately 226 ft. by 173 ft. The main portion of the building has three floors and an attic.

The basement contains the mechanics' shops, storerooms, storage battery room, space for ventilating fans, locker and toilet rooms, in addition to a number of undergraduate labo-

ratories and separate rooms for special experimental and research work. The basement connects with the main floor of Machinery Hall through the two wings and also through a central passage. The two wings and the central passageway in the basement enclose two large interior courts of ample size for giving light into all interior rooms and also for out-of-door space for experiment.

The first floor includes an auditorium, or main lecture room, seating 150 people, in which is installed every facility for experimental demonstration in lecture and class work. In addition this floor includes large laboratories for electrical measurements and instrument testing, drawing and study rooms for advanced students, a room for students' engineering societies, three class rooms and several smaller rooms for special purposes. Access may be had also from this floor to a gallery running the full length of Machinery Hall.

The second floor contains the library and reading room, large drawing rooms, several class rooms, professors' offices, laboratories for electric illumination and other purposes. There is an attic of good elevation. It provides storage space, a room for blueprinting and liberal provision for increasing demands for laboratory space.

Machinery Hall is the principal laboratory for experiments with rotating and heavy machinery in the fields of electrical and mechanical engineering. This large space is of steel construction of factory type. It is well lighted and ventilated by means of monitor skylights and large windows on all sides. It is approximately 200 ft. long by 50 ft. wide and 24 ft. high under the room trusses and has a basement under the south end. It contains a travelling crane and the necessary switchboard for controlling the extensive system of light, power and experimental electric circuits in the building. The north end of the hall is devoted to the testing of alternating current and direct current machinery, and the south end to the testing of certain portions of the equipment in mechanical engineering, described in further detail below. The concrete floor of Machinery Hall is fitted with bed plates for the tem-

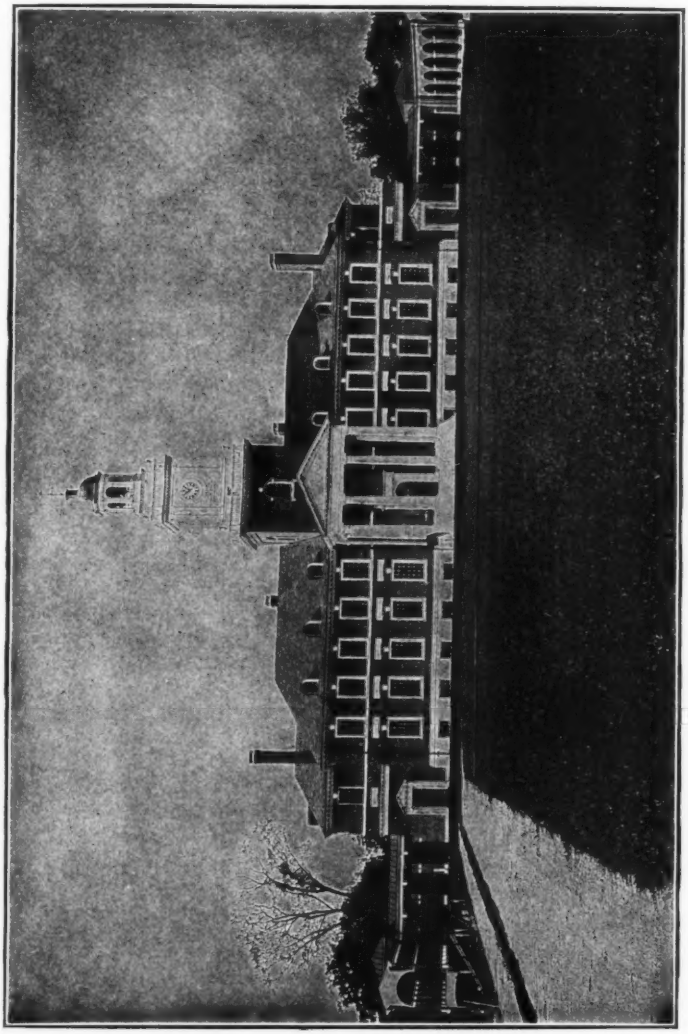

FIG. 3. The Academic Building—Front Elevation.

porary installation of machinery of various types and suitable for easy alteration of the location of the laboratory machines. There is also a gallery extending the full length of Machinery Hall, which is used for certain classes of experimental work requiring long distances.

An interesting feature of the electric equipment of the building is the system of tunnels and wire shafts whereby ready access is available throughout their lengths to the extensive open system of power, lighting and experimental cirsuits. The system of distributing boards and the method of local distribution for experiment are also interesting.

The laboratory equipment for electrical engineering is entirely modern and covers a wide field. Additions to this equipment are still in progress. The machine laboratories embrace all standard types of generators and motors. All generators are motor driven with speed control. Fixed instrument tables, rheostat and switch mountings and supports, connection posts and cable terminals are all standardized. While the student assembles all his equipment and identifies all circuits and connections, the aim has been to reduce the time required in these processes to a minimum.

In addition to the machines for the routine of instruction, a number for general and special purposes are provided; among them may be mentioned a 50 K.V.A., single phase, sine wave alternator; 2 30 K.V.A. D. C. motor-driven, 3-phase, 6-terminal machines; a 10 K.W. rotary converter; 2 7½ K.W. rigidly coupled single-phase, smooth wave alternators with ratio of frequencies 1:3, and a wide range of speed operation; alternators of 133, 600, 3,000 and 5,000 cycles; a variety of transformers, including one of 10 K.V.A. capacity at 110,000 volts, and a unit furnishing 15,000 volts continuous difference of potential.

Throughout the building a number of rooms have been equipped for the usual program of experiments in measurements, storage battery and transformer operation, arc and incandescent illumination, telegraphy, telephony and radio transmission.

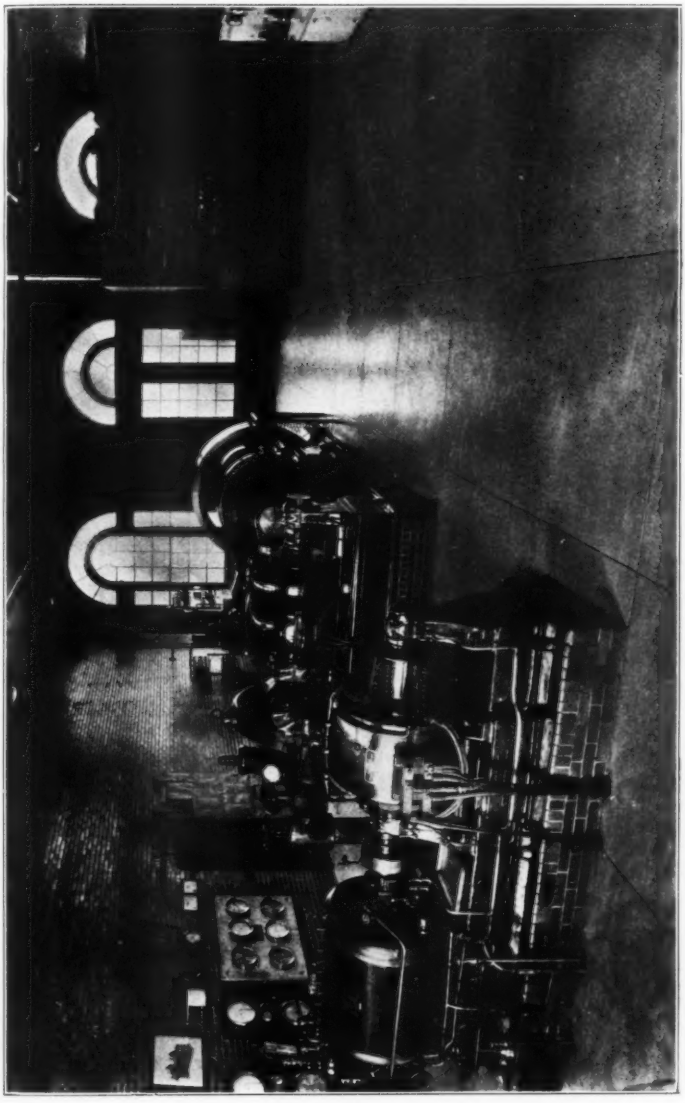

FIG. 4. Interior of Power Station.

Particular thought has been given to the facilities for special experiment and research. All types of instrument of precision are provided, numerous special machines and ample space in separate rooms. Advantage has been taken of the high point afforded by the chimney of the power station to install an antenna for radio telegraphy over 300 ft. long, the opposite end being attached to the north wing of the laboratory buildings. Opportunity and equipment is offered here also for special investigation.

The south end of Machnery Hall contains a part of the equipment for mechanical engineering, although, as indicated below, a greater portion is to be found in the power station. Among the equipment in Machinery Hall is a 6 in. by 7½ in. vertical slide-valve engine and an 8½ in by 24 in. Corliss engine, both especially arranged for valve setting and both equipped with brakes for economy and load tests.

A 15-ton Frick refrigerating machine with full equipment is also installed. The set consists of a horizontal steam engine with Corliss valve gear driving two vertical ammonia cylinders. All cylinders are furnished with reducing motions so that indicator cards may be taken. The ammonia gas, after compression, passes to a double pipe condenser on the gallery above, where the heat taken up by the cooling water can be measured. An accurate method of weighing liquid ammonia has been installed. A triple pipe brine cooler is located in the basement. The brine circulates through the cooler and is discharged over a V-notch weir into either of two weighing tanks from which it flows into a receiver tank in the basement. The system is arranged for operation either on the dry or flooded system.

There is also an air compressor of Ingersoll-Rand type, with a capacity of 400 cu. ft. per minute at 100 pounds pressure. It is compound on both steam and air ends and in this way an excellent opportunity is afforded for the study of heat interchanges. The compressed air passes into a receiver and is then discharged through an orifice.

There are two exhaust systems in the basement to which

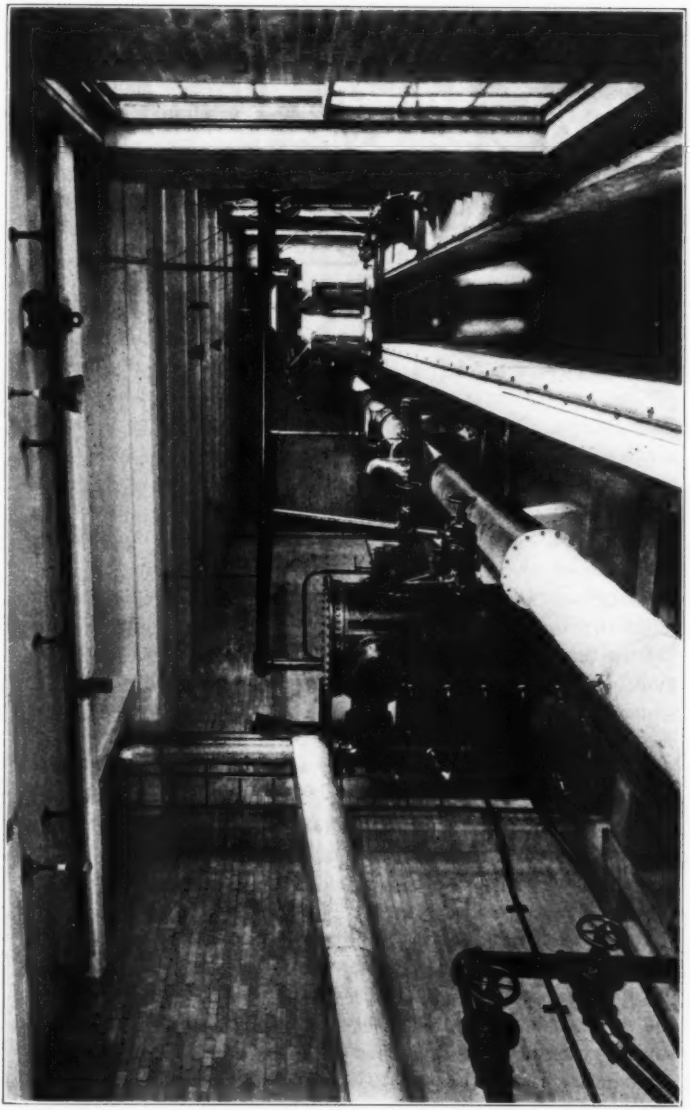

FIG. 5. Part of the Laboratory of Hydraulics.

any engine may be connected. One of these is the University heating system and the other a Wheeler surface condenser, fitted with a motor-driven Pratt Rotrex pump for high vacuum.

This portion of Machinery Hall also contains a pipe shop and a number of less striking types of machinery. Other portion of the equipment of mechanical engineering will be described in connection with the power station.

Civil Engineering Building.

The Civil Engineering Building is west of and faces the Mechanical and Electrical Building, to which it is similar in general architectural treatment. The two buildings have the same length, but the Civil Engineering Building is the smaller, in that it lacks the wings at either end, and also Machinery Hall.

In the basement three large laboratories are provided. Each laboratory suite consists of a large room for the accommodation of the heavier machines, tanks, channels for the flow of water and similar devices, and a smaller room planned especially for research. In the central portion of the building, in the wing which extends 47 ft. to the westward is the main Structures Laboratory and a research room devoted to investigation and laboratory instruction in the structural division. Here are located principally machines for testing the various materials of construction and also equipment for testing cement and sands. Opportunity and space are provided for special work on simple structural elements in full-size pieces, such as beams of various kinds, arches of reinforced concrete, brick or stone, and frame structures in wood or steel.

In the southern portion of the basement is the hydraulic laboratory consisting of a long room with specially designed channels, measuring bays and steam pipes for experiments on the flow of water, and a research room devoted to studies in sanitary engineering. In the north end of the basement are two similar rooms devoted to transportation problems which

are concerned principally with highway and canal construction, the physical elements of steam and electric railway lines, and, in general, the structural features of all that has to do with systems of transportation.

A particular type of construction has been chosen for the ceiling of the basement corridor, with a view of having an example of the pure arch structure to which the attention of students may be called. This is the "barrel" vault, so called, with arch ribs at intervals projecting three or four inches below the soffit of the vault. Over the square central portion of the corridor this vaulting is groined, giving an interesting variation in the structure. The material used is flat, hard-burned, pressed tile, laid in mortar.

On the first floor opposite the main entrance and in the wing is a lecture room, seating an audience of 400. The floor of this lecture room is level and the seats may be removed. At the west end of the room is a semi-circular bay providing a fireproof booth in which is located equipment for moving pictures. The remainder of the first floor provides four large class rooms, a department library, seminary rooms and the usual offices.

On the second floor the main divisions correspond with the similar divisions in the basement plan. At either end of the building and in the central wing are large drafting rooms. The largest is in the west wing over the lecture hall and is lighted principally from overhead by means of skylights on the north side of the roof. The steel trusses which support this roof are exposed and offer examples of structural work for the student. On this floor there are class rooms, one or two offices and rooms for other purposes, but the principal feature is the provision of abundant drafting room space. Such a large part of the work of the student in civil engineering can best be done on a drawing board, that it is of great importance educationally to provide each student in the upper classes with a desk which he does not share with anyone else. That desk is his headquarters from 8:30 to 5:00 every day. While this plan is somewhat costly, as to both space and

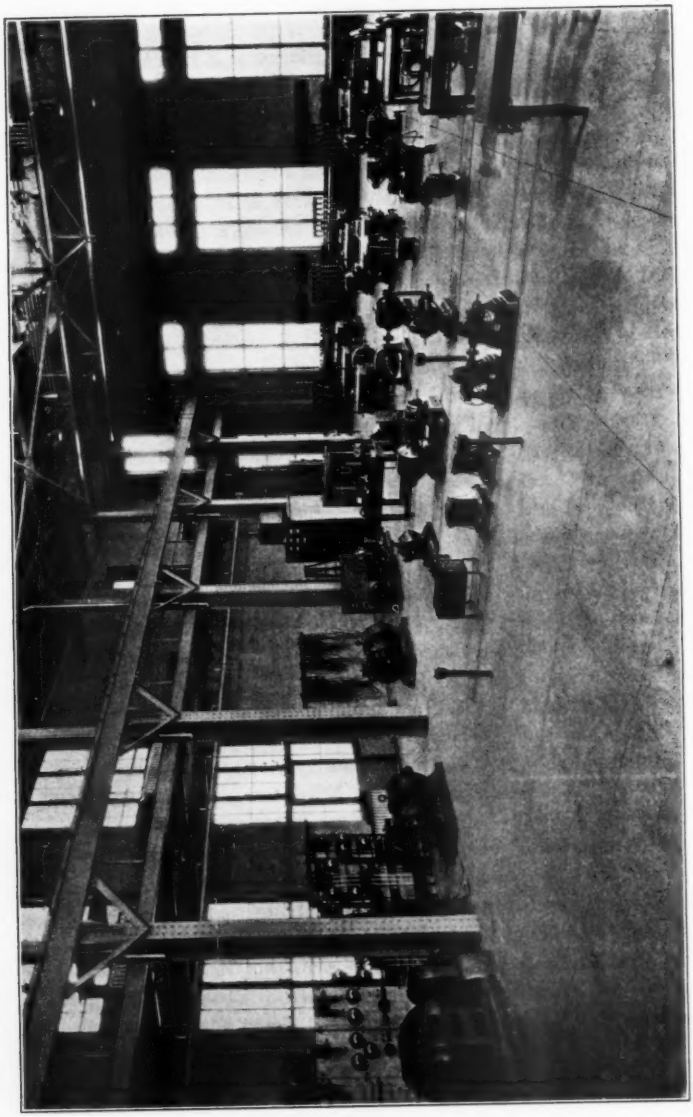

Fig. 6. North End of Machinery Hall.

equipment, it has proved in experience that the results quite justify the expenditure. The attic contains a blueprint room, a dark room and two large, well-lighted rooms, one of which will be used as a museum and the other as headquarters for a student club. Other rooms in the attic provide liberal space to meet the needs of expansion of the work of instruction.

The Power Plant.

The power plant furnishes light, heat and electric power for the entire University group. The building also contains laboratory space for mechanical and electrical engineering, and the power equipment throughout has been especially selected and amplified for its use for the purpose of instruction. The distinct divisions of the power house building comprise a coal storage bunker with overhead supply, a room for steam auxiliaries, the engine and turbine room, a gas engine laboratory, a gas producer room, and a separate laboratory containing a steam locomobile, a complete boiler and engine-dynamo in one unit.

The boiler room contains four Babcock & Wilcox water tube boilers, each of 250 boiler horse-power and an independent steam super-heater. Two of the boilers are fitted with Taylor automatic blast-type stokers with electric airmeter for controlling and measuring the air supply. The other two boilers have Roney non-blast stokers.

The engine room contains one Harrisburg 4-valve reciprocating steam engine-generator unit, one 9-stage Kerr turbo-generator and one single stage Westinghouse turbo-generator, each unit being of 100 K.W. capacity. The generators are compound wound, direct-current machines, working on a 3-wire distribution system at 120 and 240 volts. The auxiliaries room below the engine room contains the feed water equipment, condensing apparatus, steam fire pump, fan equipment for the blast-type stokers and the vacuum pumps for the University heating system. In normal operation the exhaust from the engines and turbines supplies heat for the

Fig. 6. North End of Machinery Hall.

University buildings, with suitable provision for supplementing with live steam direct from the boilers.

Special provisions for testing have been made throughout the plant. The switchboard in the engine room is equipped with duplicate sets of bus bars. One set feeds a multiple connected grid resistance, located outside the power house, capable of absorbing 25 per cent. overload on any one of the power units. In this way any unit may be separated from the normal service to the University for the purpose of testing. Also the steam piping is so arranged that a separate boiler may be used for supplying this unit. Complete measuring equipment is furnished both on the electrical and steam sides, so that the entire performance of the equipment under test may be recorded. Means are provided for condensing and weighing the exhaust steam from any one of the units, for measuring the condensing water by use of weir tanks and Venturi meters, for measuring the amount of air supplied to the automatic stoking furnaces, for analyzing the products of combustion leaving the boilers, and for weighing coal and ash.

An interesting feature of the power plant is a small self-contained steam electric unit of about 50 K.W. capacity, installed in an engine room of its own. This type of plant is known as the Locomobile, and is the most economical small steam plant available. During the winter when all of the buildings must be heated, the main power plant is operated and electric power is obtained at relatively low cost. During warm weather, when no heating is required, and when the demand for electric lighting and power is small, the main plant is shut down and the electric load carried by the locomobile. The plant consists of a horizontal, tubular boiler, with an excellent small steam engine mounted directly above and on the boiler, and arranged so that the cylinder is kept hot by direct contact with the hot gases escaping from the furnace within the water space of the boiler. In addition to

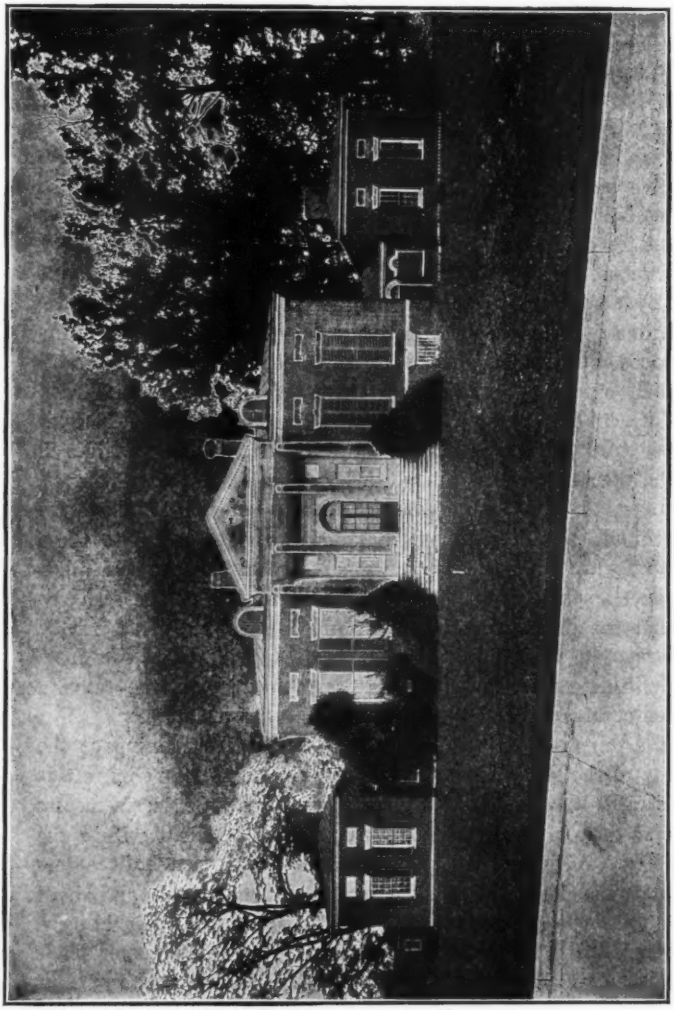

FIG. 7. The Johns Hopkins Club.

its use for this important summer service, this little plant has proven of tremendous value for purposes of instruction. It is turned over in its entirety to the students for complete operation from fuel feed to electric output.

A further interesting feature of the power plant is the provision which has been made for the study of flue gases. Arrangements are made for this study from the air supply to the boilers to the discharge of the products of combustion at the top of the 7 ft. by 150 ft. stack. This is made possible by unusual facilities for the accurate measurement of the amount of air supplied to the automatic stoking furnaces under the boilers. The products of combustion leaving the boiler furnaces and entering the stack may be chemically analyzed, and their amount under different rates of combustion, and with different kinds of fuel, determined by means of special temperature, pressure, and velocity measuring devices with which the stack has been equipped. Two galleries, or platforms, surround the stack at levels of about 50 and 80 ft. above the ground, respectively, and a ladder permits access to these platforms, as well as to the top of the stack. At each platform holes have been provided in the wall of the stack so that the pressure and velocity of the escaping gases can be measured with search tubes, Pitot tubes, etc. Aside from these determinations it is necessary to ascertain the varying temperatures from the bottom to the top of the stack. For this purpose an I-beam is placed across the opening at the top of the stack and by means of suitable attachments to this beam it is possible to raise and lower resistance thermometers and thus to determine the temperature gradient within the stack. A floor fitted with a manhole has been built across the stack just before the entrance for furnace gases and about 6 ft. above the foundation for the stack, thus providing a room under the stack. Manipulation of thermometer leads is accomplished through small holes in the manhole cover.

The various buildings of the University group are connected

with the power plant by a system of underground tunnels, through which are carried the various pipe lines and cables for heating, lighting, power, gas, water, fire alarm, telephone, clock and bell service in standard relative location. The tunnels have a minimum head room of 6 ft. and are well lighted throughout. In the ready access to all of the types of service mentioned thus provided, the tunnels constitute an interesting feature in instruction.

DISCUSSION OF REPORT OF COMMITTEE NO. 15, CIVIL ENGINEERING.

BY F. E. SCHMITT,

Associate Editor, Engineering News-Record.

Instruction in the subject of structures at engineering colleges has reached a high standard of excellence during the past several decades of development. Review of its scope and methods would, therefore, be only a task of maintenance-inspection, except for changes that have developed in professional activities and relations. Important changes of this kind have occurred, the writer believes, and particularly in view of the present abnormal conditions a reëxamination of the subject is justified. Collegiate routine has been interrupted to supply army requirements and is not yet fully reëstablished. There is opportunity for replanning courses and revising methods, the first general opportunity of the kind and one that may not be repeated for a long time.

Engineering practice as organized to-day does not bring into action more than a small part of the mental equipment furnished to the students in the present-day engineering courses. Relatively few engineers find occasion to apply directly much of the higher technical knowledge imparted to them. For the majority of technical-school graduates it seems to be true that they do not need all of the engineering education given them; and what is at least equally important, they apparently are not able to show a return on the cost of this education. The compensation paid for many kinds of engineering service—and the term "compensation" might here be taken as including more than simply money—is not above that offered for clerical services of medium grade. It is by no means sufficient to justify the investment which a modern engineering course represents.

In recent conversations with educators of long experience and unquestioned authority of opinion, the writer has been advised that engineering courses should be considered as cultural, not as bread-and-butter courses. Is this a safe view with respect to either the general planning or the detailed elaboration of the engineering course? A technical college is specifically designed to produce technical men for the technical services of modern life. Must it then not be regarded as an instrument of production, as in effect a manufacturing establishment? If so, it should be able to show that its production cost is justified by the value of its product.

But a broader question arises in immediate connection with that of returns. It cannot fail to be noticed that modern industrial organization provides for a very large and increasing proportion of medium-grade technical service, from which responsibility and independence are eliminated as far as possible. Methods have developed in such a way as to reduce in steady progression the number of responsible directing minds, those who are in a position at once to utilize their engineering knowledge and to exercise engineering judgment unhindered by external dictation. The present tendency appears to be still in the same direction. Evidently it is considered desirable at present, in the field of practice, to concentrate rather than distribute responsibility and authority; to adjust engineering operations as fully as possible to standard method and routine; and to rely upon a departmental organization composed of the largest possible number of private directed by the smallest possible number of officers.

Contrasted with forms of organization prevailing in past decades, this modern form affords fewer opportunities for advance to more responsible activity and better compensation. It will be clear that the young engineers, entering the rank of private, have a prospect of promotion in direct line limited to the small number of responsible leading positions. The axiom that there is always room at the top has only limited application under these conditions. Relief is afforded by the transfer of engineers to other but related lines of activity, a

branching-out process, but this is only a partial dependence. It remains true that of the school's output of technical men, the larger portion of those who prefer to follow the direct line of engineering service is foredoomed to a life-time of mediocre employ, not better than clerical, in either responsibility or compensation. It is to be remembered that these men belong to a class of special ability, chosen by a process of repeated selection in the successive stages of school life, and even within the technical college itself subjected to a 50 per cent. rejection process.

It may be said, in the light of these conditions, that practice and the schools are not in complete harmony. Engineering practice finds it expedient to use the majority of the engineering material placed at its disposal for routine service, and to limit it permanently to such low-grade function; and it offers a rate of compensation insufficient to justify more than a limited technical training. The schools, however, continue to furnish a high-cost four-year technical product exclusively. The conclusion is indicated that the schools fail to meet the demand of practice. If this is true, the school may have to change its methods.

This is said despite the writer's belief that the methods and tendencies of engineering practice as above suggested are faulty, and ultimately of disadvantage both to the profession and the community. The point is, however, that they exist, that engineering practice can be brought back to another course only very slowly, and that in the meantime the school's duty, to state as well as to student, is to equip the student for the demand, not to equip him for a non-existent demand or to misequip him for the existing demand.

It appears from such considerations that a shorter engineering course, and one giving the student a less refined scientific equipment, may be needed. This thought has been suggested before, but it has failed to find a warm reception. The writer believes that if the idea is regarded in its proper light, not as a merely fanciful modernistic notion, but as the

strictly logical consequence of the conditions existing, an actively sympathetic attitude toward it is bound to develop.

Short-course instruction should not disturb the long-course engineering instruction, which must continue to exist alongside of it. The long-course engineering teaching would follow the methods of the present engineering courses except as these might be adjusted so as to coördinate with the short course, and except for possible broadening. Various recent discussions have made evident a general trend of thought in the direction of reducing the more specialized or application phases of engineering teaching, in favor of a return to the teaching of fundamental engineering science and knowledge. Time economy and broadening of scope are jointly involved, and it might well prove to be true that a general engineering course extending over four or five years —the four-year term appears to be nothing other than traditional—and so worked out as to fit the student with the necessary foundation knowledge of his science and art over as broad a range of engineering activities as practicable—is the best suited for meeting the need for highly trained engineers. Such a course, then, would be the companion piece to a series of short courses so laid out as to include technical workers of a lower grade.

Only the specialist, the experienced engineering teacher, can profitably discuss courses of instruction in detail, or for that matter, in their broad aspects. The writer will, therefore, not attempt to make further suggestion as to how the conditions sketched would influence the plan of either the engineering course or the shorter technical course. However, it is obvious that the methods of teaching structures are bound to depend on the length and general plan of the course, and for this reason it appears properly within the scope of the committee's function to consider the possibility of meeting a short-course demand.

Referring more specifically to the committee's subject of discussion, methods of teaching structural designs, the writer

desires to express the view that the word "structural" should be interpreted as covering all kinds of static structures of the civil engineer's art. Steel frames, retaining walls, dams, and for that matter, ordinary walls, as well as foundations and chimneys, are dependent for strength and stability on the same group of mechanical principles and on the same general knowledge of the strength of materials. Any separation of treatment which is made in the course of teaching as a matter of convenience is likely to diminish the impression of fundamental unity of this subject which the student should acquire and should never depart from. In many college courses these several branches of the subject are dealt with in separate classes, often through separate instructors, and sometimes at periods of time separated half a year or a year. It is the writer's firm belief that the essential unity of the subject should be scrupulously respected in the arrangement of instruction in general and in detail.

If a reshaping of courses is undertaken in the immediate future, there should be opportunity for a return to unity of treatment wherever it has been departed from. The object should be to teach structures, not this and that class of structure. Segregation of the several items of the subject of structures in the teaching course is apt to weaken the student's command of structural principle. Correspondingly, the gain through unity of treatment is far greater than the loss suffered through any slight disadvantage of detail which it may involve.

One further remark on the committee's subject is invited by the word "design" in the subject title. Teaching design as a specific subject of instruction seems to the writer mistaken policy. There is necessary occasion for using examples of design in connection with the general teaching of principle, sufficient to give the student a satisfactory acquaintance with the problem of designing. To go beyond this, and give specific practice-instruction in designing, would appear to be reaching out into the field of post-graduate experience.

Teaching principle by teaching design may be proper; that is a question for the expert teacher to decide, and perhaps a primary question. But teaching designing for its own sake appears to be a diversion of college time for purposes that will be as well or better served in the course of the subsequent practical apprenticeship.

LETTER TO THE EDITOR.

MR. F. L. BISHOP,

Secretary, Society for the Promotion of Engineering Education.

PITTSBURGH, PENNSYLVANIA.

Dear Professor Bishop: I have recently requested twenty experienced teachers, largely in departments of mechanical engineering at some of our best known technical schools, to give me an opinion concerning the number of hours a week a student should devote to his work at college. I asked each of them this distinct question: "Will you check the number of hours a week which you believe should be required of an undergraduate student in engineering: this includes the total time to be spent in class, drawing, laboratory and *study.*" To this question I received the following replies:

Number voting for	0	1	5	5	3	4	0
Hours per week	44	46	48	50	52	54	56

Yours very truly,

L. P. BRECKENRIDGE,

Professor of Mechanical Engineering.

ARMY INTELLIGENCE TESTS AT UNIVERSITY OF FLORIDA.

BY J. R. BENTON,

Dean, College of Engineering.

These tests, as is well known, are intended to measure, as far as may be possible, the native intelligence of a person as distinguished from his acquired knowledge. There were applied here, under the direction of the professor of psychology, and grades were assigned in letters having the following approximate meanings:

A very high intelligence.
B intelligence above the average.
C + high average intelligence.
C average.
C — low average.
D intelligence below the average.
D — very low intelligence.

"Average" as used above, refers to average of the general population, not that of the particular group under examination. The tests used were identical with those used in the army for testing the intelligence of recruits.

The percentages of students making the various grades were as follows:

	218 College Students of All Kind (Arts and Science, Agriculture, Engineering, Law, Education). Per Cent.	60 Engineering Students. Per Cent.	158 Non-Engineering Students. Per Cent.
A	30.3	40.0	26.6
B	36.7	38.3	36.1
C+	21.1	18.4	22.2
C	11.4	3.3	14.5
C—	0.5	0.0	0.6
D and D—	0.0	0.0	0.0
	100.0	100.0	100.0

The percentages in the second and third of the above columns are obtained from the same students as the first columns, simply separated into groups of engineering and non-engineering students.

The first point of interest is the high general intelligence of the whole student body. C is supposed to represent average intelligence as found among the population in general; but the great majority of the students show higher intelligence—as they should, if they were properly selected from the population as a whole. Only one received a grade as low as C —, and he was out of health, and had to leave college shortly after the test.

The next point of interest is superiority of intelligence shown by the engineering students as compared with the others. While the number (60) of engineering students tested was not large, it was large enough to make it improbable that the high standing in intelligence was due to the accidental presence of a few men of unusual ability. I am not able to offer an explanation why our engineering students made a better showing in the intelligence tests than the others. It may be that engineering appeals more to men of superior intelligence than other studies; it may be that in our college of engineering we have been more successful in weeding out the unfit than in other branches of the institution.

CORRECTION OF FEBRUARY NUMBER.

In the discussion of General Black's address on page 238 of the February number the remarks attributed to R. C. MacLaurin are an error. These were made by W. S. Franklin.

CORRECTION OF MARCH NUMBER.

On page 259 of the March number, the name of O. J. Ferguson appears under "Names to be removed from year book due to deaths and resignations." This is an error as Professor Ferguson has not and does not wish to resign.

LIEUT. WILLIAM H. STUART.

The American Red Cross is using every effort to aid in locating Lieut. William H. Stuart, son of Duncan C. Stuart, of 12 Maple Street, Oneonta, New York, and will appreciate any information that can be secured relative to his whereabouts.

Lieut. Stuart is 27 years of age. He arrived from overseas service on January 13 and went to Washington, where he was given his discharge. He returned to New York and was last seen in that city January 18, at 7:30 P.M. He is a graduate of Colgate, Class 1914, and took two years' post-graduate work at Brooklyn Polytechnic Institute. He is 5 feet 8 inches tall, has dark brown hair and blue eyes and a ruddy complexion. He has a brown mole on the left side of his nose. He has three gold service chevrons on his sleeve indicating eighteen months' service overseas, if in uniform. He was wearing when last seen spiral puttees and not the customary leather ones for officers.

Information relative to him may also be sent to D. C. Stuart, 13 Maple Street, Oneonta, New York, or Thomas Blizard, Chief of Police, Oneonta, New York.

EDITORIAL.

In this number of ENGINEERING EDUCATION appears an article in regard to The Johns Hopkins University. At the time the School of Engineering was established at this university, a commission composed of educators and engineers made an exhaustive study and founded a curriculum based upon a much greater per cent. of humanities than was found in most of the engineering courses then in existence in the country. This was fully in accord with the character of The Johns Hopkins University. Since then, however, with the experience gained in the war, the courses have been considerably modified in order to bring into the earlier years more concrete illustrations of engineering. This is also in accordance with the report of the Joint Committee on Engineering Education. It is interesting in this connection to note that the proposed revision of courses in the Massachusetts Institute of Technology eliminate modern language from all courses except architecture and chemistry, French being required in the former and German in the latter. Here, as in the case of The Johns Hopkins University, subjects have been moved back into the freshman year. At the 1919 meeting such subjects as the above and many others will form the basis for much discussion both at the meetings and among individuals at other times. This surely is the opportune time for teachers of engineering to meet for discussion and assist in the solution of these new problems.

The Bureau of Education at Washington through its Department of Commercial Education, has called a conference of those interested in commercial education, especially in its relation to engineering, at Washington two days previous to the meeting of this society; that is on June 23 and 24. This society was represented at the preliminary conference by Dean

W. E. Mott, and the society is coöperating with the Bureau of Education in arranging the program.

The American Council on Education meets in Washington on May 2 to discuss a number of problems among them the following:

The adoption of a permanent constitution.
The election of a salaried executive for the Council.
The question of the establishment of headquarters at Washington or New York.
The annual election of officers.
Report of the committee to consider the relation between the Council and the recently established Institute of International Education; and also to the American University Union.

The society is represented on the American Council on Education by F. L. Bishop, F. W. McNair and C. R. Mann.

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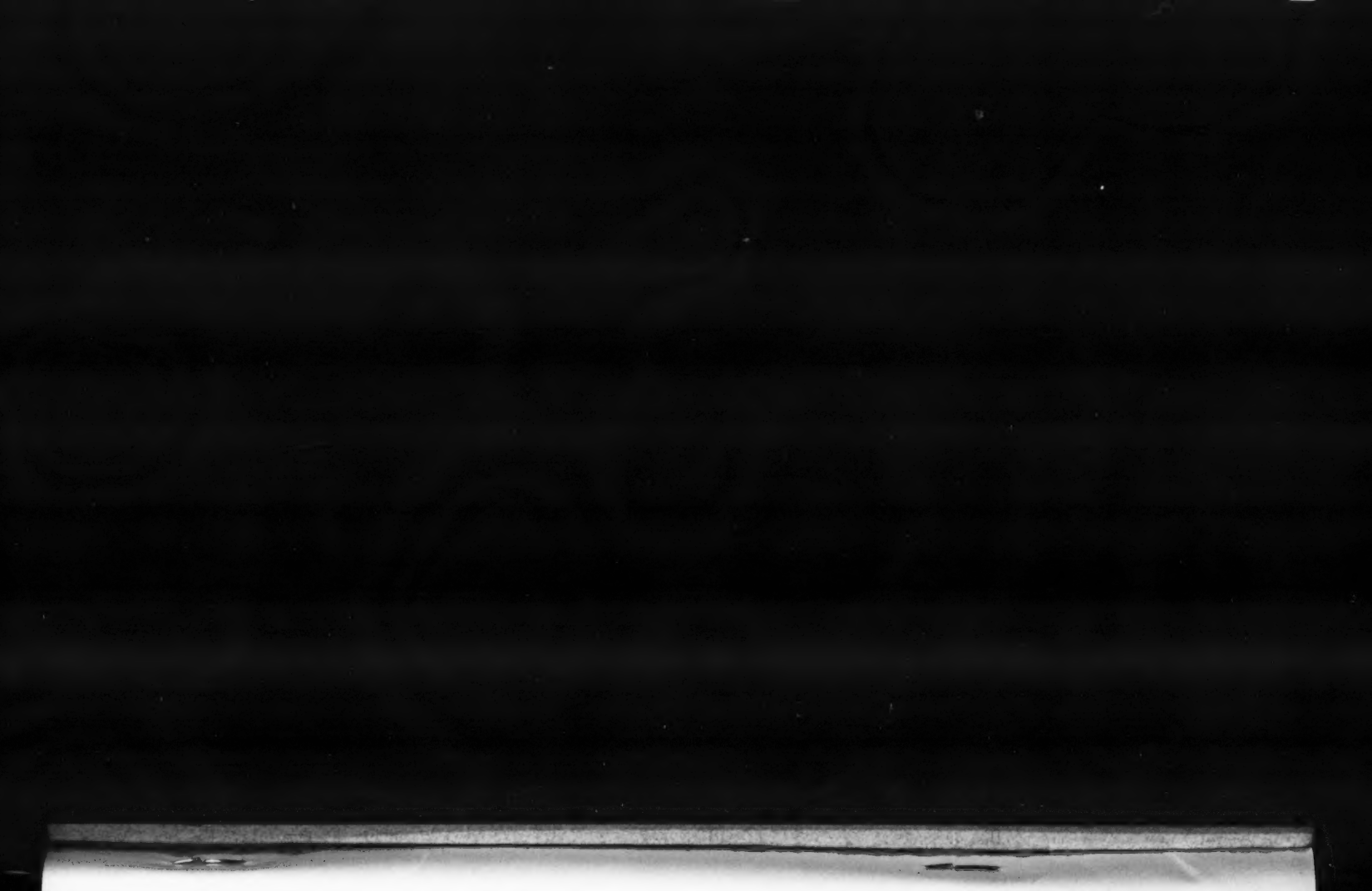

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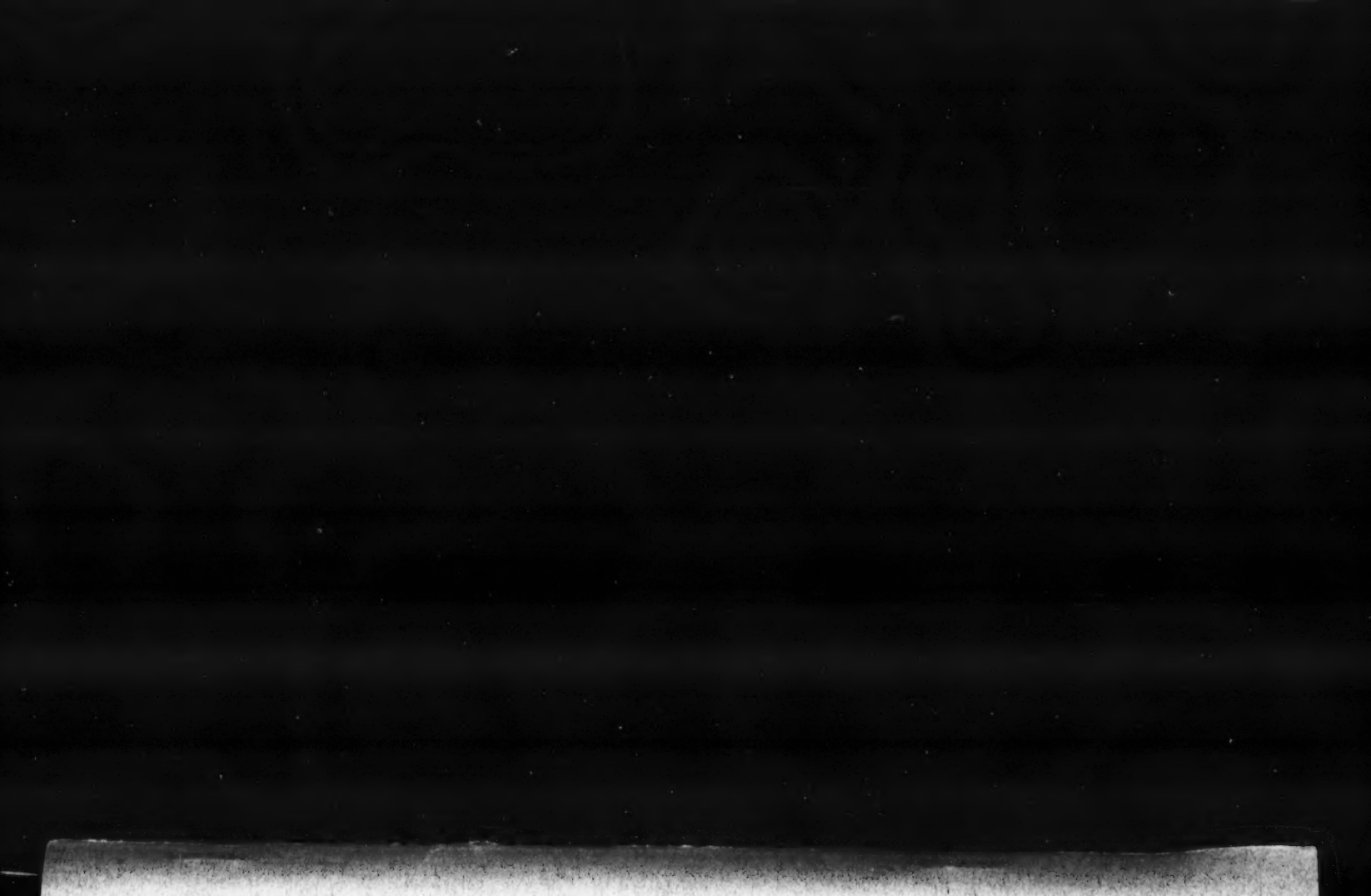
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